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ABSTRACT

A study was conducted by the Office of the Chancellor for Community Colleges in Hawaii to assess the vocational skills required of workers in the aquaculture industry and to determine if these skills should be reflected in the community college curriculum. In addition to a review of relevant literature, the study involved field observations at 17 aquafarms of varying sizes and personal interviews with their managers and/or owners. During the interviews, information was solicited concerning: (1) the length of time the farm had been in operation: (2) the use of technical advisors: (3) the salaries of managers, technicians, and field workers: (4) plans for expansion: (5) the tasks performed and the management strategies used at the farms: (6) research and development needs: (7) the future job outlook: and (8) recommendations for community college aquaculture courses. Selected findings indicate that eight of the farms had been in operation for more than five years and that 15 used technical advisors. While all interviewees planned to expand operations, most indicated that future job opportunities would be limited. Most aquafarms were experiencing problems or constraints related to the biological or chemical aspects of pond management. The study report outlines suggestions for aquaculture courses and provides a list of the tasks typically performed on an aquafarm and rates them according to frequency of performance, importance, and difficulty. (JP)

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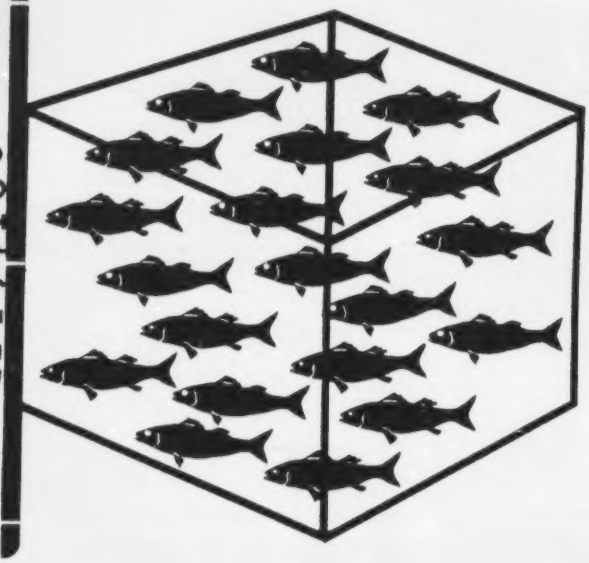

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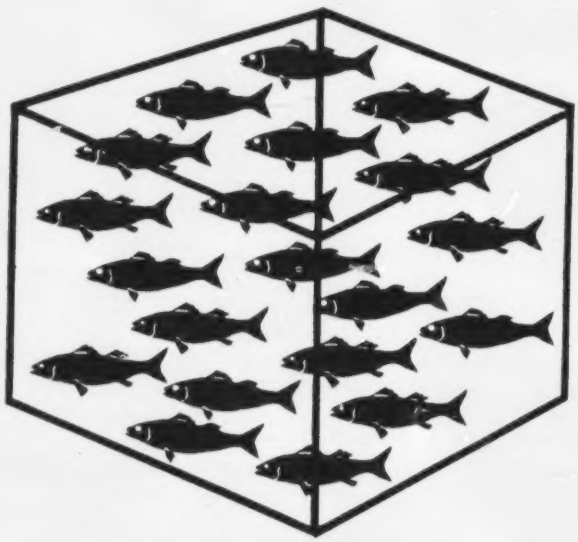

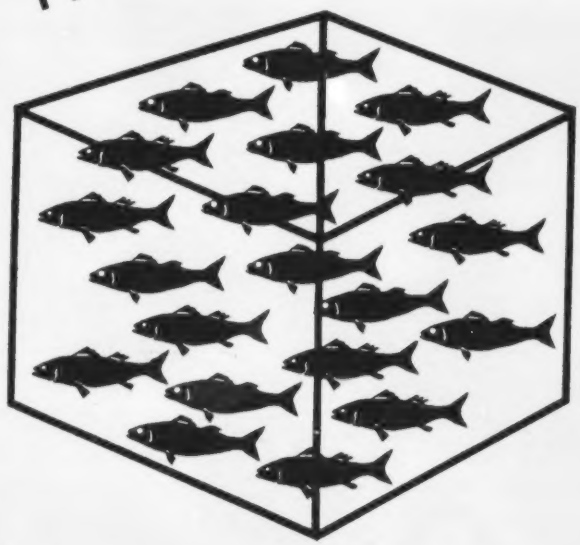

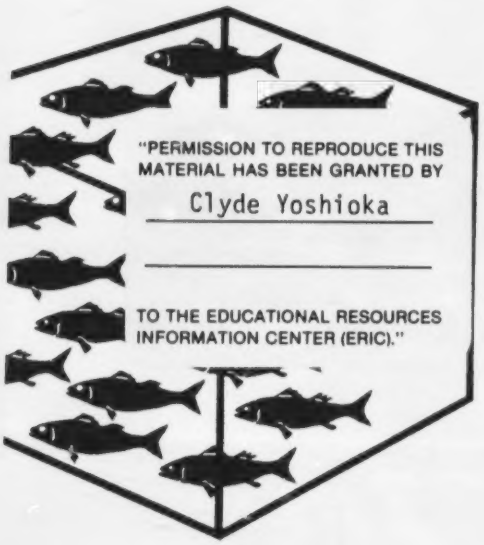

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AQUACULTURAL OCCUPATIONAL TASK ANALYSIS

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JUNE, 1980

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FORWARD

This study presents some of the essential data and information required in the development of aquaculture courses and, possibly in the very near future, programs for Hawaii's Community Colleges. This study is also timely because of the State of Hawaii's interest in developing the aquaculture industry and its projected expansion of its economic base. As a social institution engaged in the development of human resources, the community colleges must anticipate current and future manpower needs and trends and respond accordingly.

It is hoped that users of the results of this study will find data and information useful when they proceed to develop aquacultural courses.

Dewey H. Kim
Chancellor for Community Colleges
University of Hawaii

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Without the cooperation of many people, this study would not have been possible. We are indebted to the managers and owners who so kindly opened their aquafarms for observation and provided their time for interviews. Also, those who provided advice and information and critiqued the first draft are acknowledged.

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CHAPTER 1

Introduction

Since aquaculture potentially has a tremendous impact on the State, especially to the educational institutions, a study was conducted to examine the skills and knowledge required on aquafarms and to recommend, if appropriate, courses for an aquaculture program at the Community College level. Following are the situational aspects and the findings and recommendations of this study.

Need for the Study

In 1978, the Department of Planning and Economic Development's (DPED) Aquaculture Development for Hawaii, which projected production, employment, and revenues of potential species (aquatic algae, baitfish, catfish, freshwater prawn, marine shrimp, finfish, oyster, clam, and other), indicated that Hawaii will be experiencing the fastest rate of aquaculture expansion. DPED predicted an overall growth of 200% from 1978 to 1980 and another 250% growth from 1980 to 1985. Table I illustrates these figures.

These projections indicate that the expansion of the industry and the resulting impact on the education community in the immediate and long-range futures were reasons enough for a serious need to analyze the requisite skills and knowledge to aid in this projected expansion.

Table 1

Projected Production, Employment and Revenues from Aquaculture in Hawaii: 1978 to 2000*

Year	Production		Employment			Wholesale Revenues (1000s of 1978)
	Yield (1000 lbs)	Acres	Direct Jobs	Indirect Jobs	Total Jobs	
1978	427	149.0	34	49	83	931
1980	2,600	606.5	82	157	239	6,382
1985	16,785	2,429.0	313	641	954	32,644
1990	47,075	5,768.0	644	1,490	2,134	71,410
1995	93,975	12,109.0	1,273	2,879	4,152	147,988
2000	198,125	28,100.0	2,805	6,217	9,022	334,567

*Source: Aquaculture Planning Program (DPED), 1978, p. 130.

Presently more than half of the aquafarms in the State culture fresh water Malaysian prawns. This can be primarily attributed to the assistance from Anuenue Fisheries Research Center (AFRC) of the Fish and Game Division, State of Hawaii. AFRC provides aquafarmers of ponds totaling 20 acres or less, free stocking materials and technical assistance for three years. The actual acres in prawn production was 275 acres in 1979, and a projected expansion of 900 acres is expected by 1983 (Lee, 1979).

Another species, marine shrimp, is being planned for the Kahuku area. This development will consist of 100 acres of raceway culture, a feed mill and a processing plant. This is a joint venture of Coca-Cola Company and F.H. Prince Company of Chicago. Projections indicate that over 100 new aquaculture-related jobs will be created.

Kahuku Seafood Plantation is also planning an expansion of raceways to culture oysters (conversation with Dupont, 1980). The trend towards utilization of controlled raceway systems may have an impact on the training programs at the educational institutions because these systems may need workers with different skills than are necessary for pond culture systems.

Inasmuch as these projections appear to signal new job opportunities in the State, there was a definite need to examine the potential employment status, skills and knowledge required and whether or not these required skills and knowledge have implications for vocational education at the Community College level.

Identification of the Problem

In the past, Hawaiians practiced aquaculture in more than 300 fishponds; then, less than fifteen years ago a new revival in modern aquaculture occurred in Hawaii. Today, a variety of aquaculture management systems are practiced. In addition to the common pond management system, there is ocean ranching, raft and line culture, cage culture, and raceway culture systems in use throughout the world. However, in Hawaii the earthen pond management system is most common. The raceway system is becoming more popular because growing conditions can be tightly controlled.

One of the challenges to the aquaculturist in any management system is that no two sites are alike; as a result, an understanding of fundamental aquacultural principles becomes crucial for successful management. The aquaculturist must be able to adapt techniques and methods accordingly to each site's specific conditions and to correct stressful conditions quickly. Learning these skills require more than just on-the-job experience.

Fortunately, those who are already in the business but lack specific skills are able to learn by working under the supervision of aquacultural consultants, AFRC, special programs, and sometimes private research centers. The Hawaii Community Colleges hope to provide aquacultural courses to students who wish to start their own aquafarm operations, seek aquaculture-related jobs, or just wish to obtain basic knowledge as part of their general education.

Introductory aquacultural courses are offered by Hawaii's Community Colleges, but they are few and experimental. Honolulu Community College offered an introductory aquacultural technology course listed as Oceanography 97 taught by Dr, K. Gopalakrishnin. Gopalakrishnin expresses the opinion that his students enrolled in Oceanography 97 showed strong interests in furthering their education in aquaculture; but they were discouraged because there were no follow-up courses to Oceanography 97. However, HCC is contemplating to offer additional aquacultural courses and constructing an experimental lab for students to gain practical experiences in hatchery operations and cultivation of several aquatic species (conversation with Provost Yoshioka, 1980).

For the past two years, students at Windward Community College (WCC) have been participating in the "Hawaiian Backyard Aquaculture Program," a project of WCC's Marine Option Program (MOP). Students gain a "hands-on" marine skill experience through applying aquacultural and alternative energy technologies to backyard aquaculture. They are advised by Mr. Jeffrey W. Hunt and assisted by other WCC faculty and resource personnel from AFRC, Oceanic Institute, and the private industry. While there are presently no formal aquacultural courses at WCC, they are envisioned as being offered as part of the vocational agriculture program currently under

development by the college. To satisfy current student interest in aquaculture, the WCC faculty devotes special attention to aquaculture topics in BOT 181, IS 261, OCEAN 201 and ZOOL 106, 197 and 200.

For one semester in 1979, Kauai Community College offered a Skill Training Improvement Program (STIP) in conjunction with CETA (Department of Labor), which provided students with 1000 hours of training in aquaculture-related courses and practical work at Astro Marine Inc. located in Port Allen, Kauai. This was a one-shot program and no longer offered at Kauai Community College.

The University of Hawaii at Manoa has offered experimental aquacultural courses: AG 290, 390, and 490. Currently, it offers AG Engineering 498. However, other than AG 290, the courses are rigorous and requires knowledge in chemistry, biology, mathematics, and other related sciences. These courses appear appropriate for persons working toward a baccalaureate degree.

At the secondary education level, there are a couple of aquaculture exposure courses/programs available at selected high schools. These courses serve the purpose of creating interest and knowledge among students.

However, there appeared to be a lack of a follow-up, integrated, structured aquaculture program in which pre-service students, in-service workers, and entrepreneurs may enroll in to develop and perfect skills, and acquire knowledge.

Purpose of the Study

The purpose of this study was to examine the skills needed to work on and/or to manage an aquafarm and to recommend, if appropriate, whether these skills integrated into courses and program should be taught at the community college level. The information and data for this study were obtained through a search of the literature, observations of various aquafarms, and interviews with selected persons directly linked to the aquaculture industry.

Assumptions and Limitations

The following assumptions should be kept in mind because the data collected from the literature and observation of aquafarms have limitations These assumptions are:

1. Aquafarms are high risk, require high capital investments and development restricted to lands with long-term tenure and suitable environmental conditions. These factors contribute to highly competitive situations and access to data and information are not easily available.
2. Political-social-economic constraints may inhibit some aquafarms from developing or expanding, consequently, the empirical data collected maybe biased to existing operations.
3. Newly operating aquafarms have not achieved their projected maximum production level and the data presently collected may not provide an accurate assessment of present or future operations,
4. Decisions of cultivation methods maybe based on economic factors

rather than the biological needs of the cultured species.

5. Lack of technology in some aspects of production decrease efficiency and yields but may improve in the future as new skills and knowledge are developed.
6. The field observer lacked data that determined the efficiency of the tasks performed because of the developing status of the aquafarms and this may bias these tasks observations.
7. At times, task observations were not feasible, therefore, some data collected were based on interviews of entrepreneurs/ field managers and/or information contained in the literature.

CHAPTER II

Procedure in Data Collection

Data were collected through field observations, interviews, and a search of the literature. Whenever and wherever possible, person to person contacts were established in gathering data and information.

Selection of Aquafarms Visited

The DPED was contacted and its staff directed the field observer to the operating aquafarms in the State. Thirty-two aquafarms were identified for possible contacts. Questionnaires (see Appendix B) were mailed to each aquafarm with a letter of transmittal signed by the Chancellor for Community Colleges (see Appendix A). The letter explained the task analysis study and requested permission to visit the aquafarm. There were fourteen farmers that replied by mail, twelve were contacted by telephone and the remaining six could not be reached. The combined method allowed a general description from 26 aquafarms or 81% of the operating aquafarms in Hawaii. With the general description obtained, the twenty-six aquafarms were categorized by the type of species cultured and the size of the farm as shown in Table 2 of which seventeen were actually visited. It should be interjected that the size of the aquafarms was not categorized as large or small according to the actual acreage farmed, but rather, the number of persons involved to operate them. That is, a "small" farm was defined as being operated by a family unit, whereas a "large" farm was defined as requiring the help of "hired" workers.

Table 2

Number of Operating Aquafarms in Hawaii Contacted and Observed, and the Size of Farms According to the Species Cultured March, 1980

Species Cultured	Number of Contacted Aquafarms in operation (Duplicated Count)	Size of Aquafarm***	Number of Aquafarms Observed
Malaysian Prawns	6	large	4
	7	small	4
Marine Shrimps	1*	large	1*
Oysters	1	large	1
Clams	2	small	1
Catfish	1	large	
	1	small	1
Carp	2*	small	1*
Tilapia	1*	small	1*
Moi	1	small	1
Mullet, Awa, Ulua, Ahole-hole, Moi, Papio, others**	3	small	1
Hatcheries	4	large	4

*Aquafarms that culture more than one species and duplicated count under each species.

**Hawaiian fishponds containing variety of fish.

***Small = operated by family unit; large = operated with hired workers.

Interview Format

Interviews with entrepreneurs and field managers were conducted through a modified, structured format. The following types of questions were asked to obtain the desired data and information:

1. Background of the aquafarm

   a. Length of time in operation?
   b. Who and/or what were the technical advisors that helped start and monitor the operations?
   c. Salaries of entrepreneur/field manager, technicians, and field workers?
   d. Size of the farm and plans for expansion?

2. General aquafarm procedures/tasks.

   a. Tasks performed: difficulty, frequency, and skills required? (Note: This was the primary focus of the study.)
   b. Management strategies?

3. Major problems and constraints encountered on the aquafarm.

   a. Areas that need most research and development?

4. Personnel and job outlook.

   a. Desirable attributes of personnel when hiring?
   b. Job potentials in the near future?

5. Recommendations

   a. Type and content of aquaculture courses?
   b. Related courses for an aquaculture program?

CHAPTER III

Findings

Consistent with the primary purpose of the study, the emphasis in reporting the findings is focused on the identification and listing of tasks commonly performed on aquafarms. Other interview and observation findings are summarized for expediency in reporting the results, yet, retaining the essence of the meaning of the findings.

Interview Summaries

Of the 17 aquafarms and institutions visited, those interviewed provided the following general statements to the modified, structured questions:

1. Background of the aquafarm.
   a. Length of time in operation?
      1) Eight were operating more than five years.
      2) Nine were operating less than five years.
   b. Who and/or what were the technical advisors that helped start and monitor the operations?
      1) Two were independent, using basically only literature.
      2) Fifteen used technical advisors and literature.
   c. Salaries of entrepreneur/field manager, technicians, and workers?
      1) Workers' salaries range from minimum wage to $5.50/hour.
      2) Technicians' salaries were $800/month or more.
      3) Entrepreneurs/field managers were above $1000/month.
   d. Size of farm and plans for expansion?
      1) Five large farms and all plan to expand.
      2) Eight small farms of which five plan to expand.
      3) Four large hatcheries and all plan to expand.
2. General aquafarm procedures/tasks.
   a. Tasks performed and the difficulty, frequency, and skills required?
      (See Task Listing and Detailing, p. 15-35.)

b. Management strategies?

1. Management strategies are based on economic factors (profitability); however, small family operations may not be determined solely by economics but also lifestyle, personal attitudes, and desire for maximum utilization of resources and/or integration with farming.

3. Major problem and constraint encountered on the aquafarm.

a. Areas that need most research and development?

1. Each aquafarm is experiencing problem and constraint according to the species cultured, their specific site, and other factors. Basically, the problem and constraint include one or more of the following:

(a) Biological aspects of pond management due to inadequate knowledge in such areas as nutrition, behavioral and reproductive biology, and dynamics of pond ecosystem;

(b) Chemical aspects of pond management due to inadequate knowledge of water chemistry and water-quality analysis;

(c) Lack of adequate technological advancement for improving the efficiency of pond management.

4. Personnel and Job Outlook

a. Desirable attributes of personnel that you look for when hiring?

1. The most important traits of workers are good attitude, willingness to do tedious and unchallenging tasks, hard manual labor and the ability to learn and follow instructions well. Workers do not need a college degree, they will learn the required skills while on the job. Most of the full-time workers are hired from within the community and the starting pay is minimum wage plus benefits. However, when feeding/harvesting mechanizations and intensified culture systems are implemented, they may result in a decreased need for lower skilled workers and an increased need for higher skilled workers but at a lower manpower need level.

Larger farms usually hire technicians with an associate or bachelor's degree, but a worker with several years of experience may be able to fill the technicians' position; however, advancement beyond the technician's level are rare for these people.

Large farm field managers should possess at the minimum an associate degree (preferably a B.S. degree), work experience in aquaculture, and a "broad" knowledge of biology, chemistry, ecology, agricultural engineer, carpentry, plumbing, and supervisory skills. An entrepreneur of a small farm does not need a college degree because of his status; however, the basic skills as mentioned above are still essential. These general skills are required no matter what aquatic species cultured. As aquaculture management systems increase in size and complexity, the field manager must also increase his managerial skills to achieve projected higher yields, shorter production time, and/or better quality product to maintain viability and profitability.

b. Job potentials in the near future?

1. Job opportunities in the future are still limited; the most available positions are filled by workers (low skilled) from within the community. Technical positions are usually available when large farms expand. Field managerial positions are few in number. Entrepreneurs may find it difficult to start their own aquafarms due to high capital investments and high risks involved.

One interviewee said that a person with a two year degree or certificate in aquaculture may find a job easily because he or she may be more willing to start at minimal wages and work toward advancement in comparison to a person with a bachelor of science degree who may not be willing to start at lower wages.

5. Recommendations

a. Type and content of aquaculture courses?

1. Two of the interviewees who are qualified aquaculture consultants and experienced teaching at the Community College level suggested a sequence of courses that would be most appropriate for students preparing for employment in aquaculture. Two suggested course outlines are as follows.

SUGGESTION A:

Aquaculture I: Study of aquatic species and cultivation practices. Includes the study of finfish (carp, trout, catfish) and shellfish (shrimp, prawn, crayfish, oysters, mollusc), the biology of each species and cultivation practices. Prerequisite: 6 credits in biology.

Aquaculture II: Study of pond ecology, population dynamics, chemistry of water and its qualities, and business management of aquafarms. Prerequisite: 6 credits in business.

Aquaculture III: Practical work on an aquafarm or institutional laboratory to gain exposure. Recommended that this course be taken in the early part of the aquaculture program.

SUGGESTION B:

Aquaculture I: Introduction to aquatic species, study of their biology and cultivation practices, study of pond ecology and population dynamics. Some lab work included;

Aquaculture II: Pond lay-out, design, permit requirements and construction. Lab work included;

Aquaculture III: Study of water chemistry and water-quality monitoring systems, nutrition and supplemental feeding and hatchery operations. Lab work included;

Aquaculture IV: Pond management strategies (business) and harvesting and marketing methodologies;

Aquaculture V: Introductory course in carpentry, welding, plumbing and heavy equipment operations;

Aquaculture VI: Field work in aquafarms to gain practical experience.

Both interviewees suggested that a counselor be available to counsel students concerning other appropriate courses that would be beneficial depending on the students' educational goals.

b. Related courses for an aquaculture program?

1. The interviewees agreed that the following related courses be included in the aquaculture training program:

(a) Biology and related sciences are most crucial.

(b) Carpentry, plumbing, and heavy equipment operations are most helpful.

(c) Business management, statistics, and ecology are necessary for entrepreneurship.

(d) Some interviewees stressed the importance of chemistry but most of them said that only applied chemistry should be included in the aquaculture course itself.

Task Listing and Task Detailing

This section comprises of the general activities expected on both large and small scale aquafarms that cultivate most aquatic species. The data were gathered from the literatures, interviews, and personal observations of various aquafarms. The primary use of these data and information is for the purpose of curriculum development--course content and learning experiences.

Task Listing: This is the list of tasks performed on an aquafarm as a result from the findings. These tasks have been listed on a standard form and numbered; each task has been further categorized and rated as to the frequency of performance, the importance, and the learning difficulty. The rating scale is as follows:

1. Frequency of Performance Rating:

   1 = continously: constant awareness and regular monitoring required.

   2 = daily; task conducted on a daily basis; such as feeding.

   3 = weekly; not necessarily done once in seven days but attention should be given to the task and done when necessary; a delay of a few days is not very harmful.

   4 = monthly; attention should be given to the task but a delay of a couple weeks in performing the task will not be harmful. Ratings (3) and (4) are similar in that the farmer must look at the condition and analyze the other factors that may be affected directly or indirectly by such a task.

   5 = yearly; task performed once every several months to a year.

II). Importance Rating:

1 = very important: quality of the task may determine the success or failure of the operation or may be the casual agent to other serious problems.

2 = important: quality of the task will influence the efficiency of production and operating costs.

3 = not too important: quality of the task is such that it will not cause the failure of the operation but may cause side effects and a decrease in efficiency.

III). Learning Difficulty Rating:

1 = easy: Person does not require special training or a college degree; required skills are usually part of a worker's everyday skill requirements such as driving a car. Also means that the person may obtain "free" technical assistance through a service agency.

2 = moderate: person must go through a special training program to attain the required skills; comparable to a community college education.

3 = difficult: person must go through intense training such as a four-year college or needs professional assistance from one that charges a fee, such as a lawyer.

Task Detailing: is a list of activities in accomplishing a task. The task number from the task listing (see p. 18) is correlated with the number assigned to the task detailing (see pp.19-35). The list of activities are on a standard form with each activity categorized for the type of performance required and learning difficulty involved.

The five possible types of performance ratings are:

1 = speech: person must have the ability of convincing a group of people such as a lawyer convincing a jury of his theories.

2 = recall: ability to retain knowledge or the ability to do research to solve a problem.

3 = manipulation: to work, operate, or control with use of hands, intellect, and/or mechanical processes,

4 = discrimination: ability to distinguish or select,

5 = problem solving: ability to identify and deal with any obstacles or improve efficiency of an operation.

The learning difficulty ratings are:

Ratings are the same as the learning difficulty in Task Listing, i.e., 1=easy; 2=moderate; and 3=difficult.

The listings of tasks (Task Listing) and activities for each task (Task Detailing) are reported on the following standardized forms, found on pages 18 through 35.

TASK LISTING

JOB TITLE: Starting and Maintaining and Aquafarm

OCCUPATION: Entrepreneur

INDUSTRY: Aquaculture of warm water organisms

RATING:

Frequency of Performance: 1 = Continuously; 2 = Daily; 3 = Weekly
4 = Monthly; 5 = Yearly
Importance: 1 = Very Important; 2 = Important; 3 = Not Too Important
Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	Tasks	RATINGS		
		Frequency of Performance	Importance	Learning Difficulty
1.	Locate a feasible aquaculture site.	initial	1	2
2.	Select an aquatic species to site's climatic and aquatic environment.	initial & modifiable	1	2
3.	Fulfill private and governmental requirements.	1	1	1,2,3
4.	Design general draft of an economically feasible aquafarm and operating strategies.	initial & modifiable	1	2,3
5.	Construction of grow-out systems:	initial	1	1,2,3
	a. earthen pond			
	b. cage			
	c. concrete raceway			
	d. other			
6.	Stock target species into growout pond.	5	1,2	1
7.	Cultivation of species:			
	a. manage water quality and system	1	1	2
	b. manage pond's natural productivity	1	1	2
	c. control excess aquatic vegetative growth	3,4	2,3	1
	d. supplemental feeding	2	1,2	1,2,3
	e. pond maintenance and improvements	4,5	2,3	1,2,3
8.	Harvest, process, and transport to marketplace.	3,4,5	1	1,2
9.	Methods and techniques to increase production of cultured species.	1	1	2,3

TASK DETAILING

TASK NUMBER: 1 : Locate a feasible aquaculture site.

JOB STATUS: Entrepreneur

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Analyze environmental resources and whether or not it is economically feasible for aquaculture:		
	a. water source, quality, and quantity	2, 3,4,5	1,2,3
	b. soil characteristics	2, 3,4,5	1
	c. topography of site and surrounding areas, and slope	2, 3,4,5	1
	d. climatic conditions	2,3,4,5	1
	e. prior usage of land site	2,3,4,5	1
	f. accessibility throughout the year	2,3,4,5	1
	g. activities of surrounding area (insecticide spraying, animal husbandry, etc.)	2, 3,4,5	1
2.	Analyze economic factors:		
	a. tenure of site	2,3,4,5	1,3
	b. initial capitial investment for construction and operating	2,3,4,5	2
	c. environmental conditions that will affect production cost (pumping, electricity, etc.)	2,3,4,5	2
	d. level of security needed	4,5	1
	e. transportation means and distance to market-place	2	1
	f. local competitors	2,5	2
	g. type and cost of manpower	2,4,5	1

TASK DETAILING

TASK NUMBER: 2 : Select an aquatic species adaptable to the site's climatic and aquatic environment.

JOB STATUS: Entrepreneur

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate, 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Analyze whether the aquatic species is viable in that environment at a feasible cost:		
	a. sources and availability of stocking species	2,3,4,5	2
	b. stocking density and rates	2,3,4,5	2
	c. feeding requirement and sources, availability, cost, quality, quantity, etc.	2,3,4,5	2,3
	d. growth rates	2,3,4,5	2
	e. behavioral response to environmental stress, handling, and transporting	2,3,4,5	2,3
	f. vulnerability to disease and predators, and response to treatment	2,3,4,5	2,3
	g. behavior patterns which will influence management strategies	2,3,4,5	2,3
	h. harvesting strategies and frequencies	2,3,4,5	2
2.	Analyze marketability of selected species:		
	a. demand throughout the year and its stability	2,3,4,5	2,3
	b. supply throughout the year and degree of saturation	2,3,4,5	2,3
	c. wholesale and retail prices	2,3,4,5	2
	d. consumer's preferences	2,4,5	2,3
	e. similar and substitute products	2,4,5	2,3
	f. expense and cost	2,3,4,5	2,3
	g. gross and net profits	2,3,4,5	2,3
	h. rate of return	2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 3 : Fulfill private and governmental requirements.

JOB STATUS: Entrepreneur

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Establish some form of business.	1,2,3,4,5	2,3
2.	Gain capital securities.	1,2,3,4,5	2,3
3.	Upon selection of site, species, and production strategies obtain required permits and any necessary statements.	1,2,3,4,5	2,3
4.	Develop a five year cash flow plan.	2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 4 : Design a general draft of an economically feasible aquafarm and operating strategies.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Designing a general draft requires analyzing all environmental factors, species, biological requirements, type of production system, cost, etc.		
	a. lay-out plan for production system	2,3,4,5	2,3
	b. construction and operating costs	2,3,4,5	2,3
	c. expected problems and solution	2,3,4,5	2,3
	d. market supply and demand	1,2,3,4,5	2,3
	e. overall stability and flexibility	1,2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 5a : Construction of Growout System: Earthen pond

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Examine topography and design general pond(s) system that will:		
	a. meet the biological needs of the cultured species	2,3,4,5	2
	b. meet the ecological needs of the cultured species	2,3,4,5	2
	c. utilize the topography and environment in such a way to minimize operating costs	2,3,4,5	2
	d. allow harvesting methods to be efficient	2,3,4,5	2
	e. allow construction cost to be minimal	2,3,4,5	2
2.	Remove trees, shrubbery, rocks, and any other obstacles that may interfere with operations and pond quality. Measure and mark out pond. Excavate and level pond bottom (usually done by a contractor).	2,3,4,5	1,2
3.	Upon excavating pond bottom, unexpected topography features may be revealed, examine whether modifications in the general pond lay-out plans must be made.	2,3,4,5	1,2
4.	Compact pond bottom. Install drainage system, water inlet and outlet, and build and compact pond embarkment.	2,3,4,5	1,2
5.	Construct drainage channel for water outlet system.	2,3,4,5	1,2
6.	Examine whether soil in pond needs to be conditioned and/or treated prior to stocking fish.	2,3,4,5	2, 3
7.	Some aquaculturist install primary and secondary ditches in pond bottom to allow water to drain easily, pending on species and harvesting schemes	2,3,4,5	2, 3
8.	Plant grass along pond's embankment and surrounding area.	2,3,4,5	1,2

TASK DETAILING

TASK NUMBER: 5b : Construction of Growout System: Cage

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Select appropriate type and size of cage to:		
	a. meet the biological need of the cultured species	2,3,4,5	2
	b. withstand the environmental elements	2,3,4,5	2
	c. endure pressure of water current and when transporting	3,4,5	2
	d. allow supplemental feeding	2,3,4,5	2
	e. screen out predators	2,3,4,5	2
2.	Examine unit cost per cage in relation to operating, harvesting, yields, and net profit, etc.	2,3,4,5	2,3
3.	Design cage lay-out system in pond, lake, or ocean by considering all factors: i.e., position of cages in water column, water quality and circulation, predators, disease, cultivating, transporting, unexpecting problems, and security.	2,3,4,5	2,3
4.	Construct cages to endure interaction with environment.	2,3,4,5	1,2
5.	Install and secure cages.		
6.	Maintain condition of cages throughout the rearing period.	2,3,4,5	1
7.	Record keeping and collecting data.	2,3,4,5	1,2

TASK DETAILING

TASK NUMBER: 5c : Construction of Growout System: Concrete Raceway

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
	Raceway, being an intensive cultivating system, is ideal when water is limited, soil type and/or topography are uneconomical to construct earthen ponds, or to gain better control over the aquatic environment and water circulation. Raceway is a long narrow channel made out of concrete, fiberglass, or other materials and contains wired headwalls to separate the channel into sections to direct water flow. Some standard suggested features are:		
	a. dimension: 2 or more meters in length, 50 to 91 centimeters in width, and .91 to 1.2 meters in depth		
	b. inside channel's angles may be rounded and painted with waterproof paint		
	c. slope or basin to increase efficiency of draining		
	d. inlet water pipe, drainage system (screened standpipe)		
	Design and construction of raceways usually require professional assistance.	2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 6 : Stock Target Species into Growout Pond

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS: Type of Performance	RATINGS: Learning Difficulty
1.	Stocking density depends on:		
	a. total productivity of the pond		
	1) natural productivity 2) supplemental feeding and/or fertilizer	2,3,4,5	1,2
	b. size of pond	2,3,4,5	1,2
	c. biological characteristics of target species	2,3,4,5	1,2
	d. and economic (profitability) factors	2,3,4,5	2,3
2.	Check that stocking material are healthy.	2,3,4,5	1,2
3.	Monitor pond for predators that may prey on stocking material. Correct problem and/or determine stocking strategies.	2,3,4,5	1,2
4.	Acclimate stocking material to pond water and temperture, then release.	3,4	1

TASK DETAILING

TASK NUMBER: 7a : Cultivating of Species: Manage water quality and system.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1	Water quality may influence the growth of the cultured species and development of the pond's natural productivity (a food source for the species); therefore it must be crucially controlled. Just a short period of poor water quality may cause stress or fish kills; optimal conditions on the other hand will allow the species to utilize it's energy toward physiological maintainence and growth.		
	a. temperature control (depth of pond, water color, Herrguth type monk, etc..)	2,3,4,5	2
	b. dissolved oxygen control (water inlet cascades, aerator, flushing, plant density, etc)	2,3,4,5	2
	c. pH control (liming, fertilizers, etc.)	2,3,4,5,	1,2,3
	d. phytoplakton density	2,3,4,5	2
	e. other		

TASK DETAILING

TASK NUMBER: 7b : Cultivating of Species: Manage pond's natural productivity.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS: Type of Performance	RATINGS: Learning Difficulty
1.	A pond's natural productivity serves as food source to the species population, may be determined by analyzing such factors as:		
	a. biogenic capacity: nutritional value and richness of the fish as food	2,3,4,5	2
	b. quality of food present that meets the nutritive requirements of the fish	2,3,4,5	2,3
	c. quantity of food:	2,3,4,5	2
	1) population of aquatic animal organism dependent on aquatic plant available		
	2) aquatic plant population dependent on pond bottom, physico-chemical characteristics, turbidity, etc.		
	d. environmental influences on biogenetic capacity:		
	1) temperature	2,3,4,5	2
	2) sunlight	2,3,4,5	2
	3) water chemical characteristics	2,3,4,5	2,3
	e. pond characteristics	2,3,4,5	2
	1) size and volume		
	2) soil type and characteristics		

TASK DETAILING

TASK NUMBER: 7c : Cultivating of Species: Control excess aquatic vegetation growth.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS: Type of Performance	RATINGS: Learning Difficulty
	Excess vegetation (especially, emergent, floating, and submerged weeds) is a nuisance to a pond system, decreases pond productivity, harvesting efficiency, turbidity, serves as a host and refuge for predators and insects, and accelerates silting.		
1.	Removal of excess vegetation on a regular basis may be done through one or combination of the following:		
	a. Biological methods		
	1) allow only acceptable plants to colonize; erradicate unfavorable ones	2,3,4,5	2
	2) introduce herbivorous animals as control	2,3,4,5	2,3
	3) remove weeds; then allow phytoplankton growth to decrease light penetration	2,3,4,5	2
	b. Mechanical method		
	1) cut and remove undesirable plants while still tender or prior to flowering stage; tools such as scythe and mechanical aquatic cutter are ideal to use. Loosely rooted and floating plants may be removed by hand and/or rakes	2,3,4,5	1,2
	2) regulate pond's water level and color to alter the sunlight's penetration to submerged plants	2,3,4,5	2
	3) till soil when pond is drained and dried	2,3,4,5	2
	c. Chemical methods		
	1) caution taken when selecting and applying herbicides (may be harmful to target species, personnel, and nearby crops)	2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 7c : (Continue)

JOB STATUS:

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
	2) determine the appropriate measures in herbicides application	2,3,4,5	2,3
	a) carefully measure surface and/or volume of water in pond	2,3,4,5	2
	b) if pond should be dried when treated, then determine when feasible to stock again	2,3,4,5	2,3
	c) if pond should be filled with water when treated, then determine the proper disposal of treated water and plants	2,3,4,5	2,3

TASK DETAILING

TASK NUMBER: 7d : Cultivating of Species: Supplemental feeding.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Select feeds to meet nutritional requirements of target species.	2,3,4,5	2,3
2.	Determine feeding rates and amount.	2,3,4,5	2,3
3.	Some feed formulas require preparation such as mixing, mincing, drying, and/or cooking.	3,4,5	1,2
4.	Proper storage of food is important.	2,3,4,5	1,2
5.	Apply feeds manually, mechanically, and/or automatic feeders.	2,3,4,5	1,2

TASK DETAILING

TASK NUMBER: 7e : Cultivating of Species: Pond maintenance and improvements.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Remove trees and shrubbery to prevent roots impairing pond's embankment, waterways, and harvesting.	2,3,4,5	1,2
2.	Harvesting of some species requires draining the pond which allows farmers to restore pond bottom prior to refilling; species harvested without draining pond should still be drained periodically for restoration.	2,3,4,5	2
3.	Upon draining, the farmer must determine the type and cost of improvement and restoration needed:	2,3,4,5	2
	a. pond bottom should be dried and cultivated to:		
	1) control unfavorable plants		
	2) improve biological, chemical, and physical properties of the soil to increase pond productivity.		
	3) improve hygienic conditions		
	4) treat soil with fertilizer, lime, or other types of chemical if needed		
	5) increase mineralization of mud.		

TASK DETAILING

TASK NUMBER: 7e ¢ (Continued)

JOB STATUS:

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
	b. remove excess mud, silt, and detritus; method used determined by pond size and cost 1) pond bottom dried, then dredge with shovel, dragline, bulldozer, or strong jet of water 2) pond that cannot be drained use suction dredge 3) re-level bottom, repair banks, water inlets and outlets		

TASK DETAILING

TASK NUMBER: 8 : Harvesting, processing, and transport to marketplace.

JOB STATUS: Entrepreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Harvesting methods and techniques are determined largely on the behavior and response patterns of target species.		
	Harvest methods:		
	a. drain/seine pond	2,3,4,5	2
	b. seine pond		
	c. harvest species behind monk and dike		
	d. mobile trapping boxes		
2.	Processing		
	a. sort and grade	3,4,5	1,2
	b. fresh species are chilled or kept in tanks		
	c. frozen species may be "as whole", "tails only" or "fillet" depending on market's preference.		
	d. some species require additional treatments as with oysters	2,3,4,5	2,3
3.	Transport to marketplace	3,4,5	1,2
	a. fresh species require container with aerator devices and cool water or on ice		
	b. frozen species require freezing equipment		

TASK DETAILING

TASK NUMBER: 9 : Methods and techniques to increase production of a cultured species.

JOB STATUS: Enterpreneur/field manager

RATINGS:

Type of Performance: 1 = Speech; 2 = Recall; 3 = Manipulation; 4 = Discrimination; 5 = Problem Solving

Learning Difficulty: 1 = Easy; 2 = Moderate; 3 = Difficult

No.	TASK DETAILS (ACTIVITIES IN PERFORMING THE TASK)	RATINGS	
		Type of Performance	Learning Difficulty
1.	Intensive aquaculture means culturing the highest amount of target species in a given area; and therefore, one can expect intensifying problems. There are many methods and techniques to deal indirectly or directly with these problems. Some of these are listed below, but not all of these have been used by farmers in Hawaii.		
	a. liming the pond bottom	2,3,4,5	2
	b. fertilizing the pond	2,3,4,5	2
	c. polyculture vs. monoculture	2,3,4,5	2,3
	d. polysex vs. monosex culture	2,3,4,5	2,3
	e. rotation of pond culture/ag crops/animals	2,3,4,5	2
	f. stocking frequency and rates	2,3,4,5	2,3
	g. sorting population size and/or ages, then segregate into different ponds	2,3,4,5	2
	h. supplemental feeding techniques and formulas	2,3,4,5	2,3
	i. harvesting techniques	2,3,4,5	2,3
	j. pond engineering	2,3,4,5	2,3

Although the data for Task Listing and Task Detailing may be more applicable to the earthen pond management system, the basic skills needed to perform these tasks are also utilized in other aquacultural management systems and cultured species. Even though task listing and detailing have been identified, another observer could possibly add to the findings. However, the data and information in this report should be adequate for the development of an aquaculture curriculum.

Almost all of the tasks listed in Task Listing and Task Detailing had the rating of two (2), indicating moderately difficult learning material. Therefore, formal classroom and field work experience may provide an effective learning environment. Based on these findings, there should be an aquaculture curriculum offered in educational institutions.

CHAPTER IV

Summary, Conclusions, and Recommendations

Included in this chapter are (1) a summary of the study, (2) conclusions drawn based on the findings of this study, and (3) recommendations that appear appropriate based on the conclusions.

The Department of Planning and Economic Development has recommended that an aquaculture curriculum should be included in Community Colleges. This recommendation and growing student interests has stimulated the Chancellor for Community Colleges to conduct a study in dealing with the possibility of starting an aquaculture program. A study was conducted to identify and list the skills and knowledge required on aquafarms.

In order to develop an aquaculture curriculum or sequence of aquaculture courses it was necessary to understand the operations of aquafarms. Thus, a review of the general skills and knowledge needed to culture feasible aquatic species was examined. Since no two aquatic sites are alike and since technological applications must be modified accordingly, direct observations of various aquafarms operations were compiled to develop insight into the required skills and knowledge in aquafarm operations and management. The skills and information that were identified could serve as a basis for developing an aquacultural curriculum.

Through a mail survey and telephone follow-up of nonrespondents, it was possible to identify and select 17 aquafarms of different sizes, cultured species, and management strategies for observation. These observations and interviews with aquafarm operators and workers, resulted in the listing of tasks that are performed on aquafarms and related activities involved in accomplishing these tasks.

Each of the tasks was further categorized into three associated factors: frequency of performance, importance, and learning difficulties. These factors were measured on various rating scales for the purpose of developing an appropriate aquaculture curriculum to prepare students with the skills and knowledge required. In addition, each of the tasks was amplified by detailed listing of steps required to perform and accomplish these specific tasks. Similar to the tasks, each of the steps was also rated

Interviews were conducted at the visited aquafarms with entrepreneurs and/or field managers. Generally, all of the interviewees agreed on the skills and knowledge that should be possessed by aquafarm employees and/or employers. They also generally agreed that the community colleges should gear their aquaculture courses/

programs toward entrepreneurship and technical positions.

These data appeared to indicate that much of the technical skills and knowledge could be taught at the Community College level; this was particularly evident in the Task Detailing list where most of the activities were rated as moderately difficult to learn. Manual laborers, on the other hand, could be trained on-the-job, and, therefore, do not need a formal post-high school educational background.

Conclusions

The primary purpose of this study was to compile the essential skills and information required for an aquafarm operation. This was accomplished through literature research, field observations and personal interviews and have been analyzed in Task Listing and Task Detailing (pp. 15-35). These data and information can now be used for development of aquaculture courses/programs geared towards Community Colleges. A general job task description could be offered in the introductory courses with more details added and content increased in higher course levels. It can be further concluded that there is a body of knowledge worth learning.

Since aquaculture involves high risk factors and intensive capital investment, it is recommended that interested people, contemplating starting their own farm operation, be educationally prepared, and for those who seek employment within the industry, educational preparation opens more doors for job opportunity in this expanding field.

However, it is also concluded that the industry is still in its developmental stages and the prospects of trained persons finding employment are limited. The industry currently utilizes unskilled workers who are trained on-the-job for the manual tasks that are performed on aquafarms. Therefore, at this point in the development of the aquaculture industry, there does not seem to be a need for a full-fledged program that would lead to an associate degree or a certificate of achievement in aquaculture. What appears to be needed is a series of courses that may lead to a certificate of completion in aquaculture. In this respect, the following are suggested:

SUGGESTION A:

Aquaculture I: Study of aquatic species and cultivation practices. Includes the study of finfish (carp, trout, catfish) and shellfish (shrimp, prawn, crayfish, oysters, mollusc), the biology of each species, and cultivation practices. Prerequisite: 6 credits in biology.

Aquaculture II: Study of pond ecology, population dynamics, chemistry of water and its qualities, and business management of aquafarms. Preprequisite: 6 credits in business.

Aquaculture III: Practical work at an aquafarm or institution to gain exposure. Recommended that this course be taken in the earlier part of the aquaculture program.

SUGGESTION B:

Aquaculture I: Introduction to aquatic species, study of their biology and cultivation practices, study of pond ecology and population dynamics. Some lab work included.

Aquaculture II: Pond lay-out, design, permit requirements and construction. Lab work included.

Aquaculture III: Study of water chemistry and water-quality feeding monitoring systems, nutrition and supplemental feeding and hatchery operations. Lab work included.

Aquaculture IV: Pond management strategies (business) and harvesting and marketing methodologies.

Aquaculture V: Introductory course in carpentry, welding, plumbing and heavy equipment operations.

Aquaculture VI: Field work in aquafarms to gain practical experience.

Of course, availability of resources (financial, facilities, equipment, personnel) will dictate whether a campus or a school should or should not offer these suggested courses. In addition and of equal importance, is the availability and accessibility of aquafarms and laboratories for students to observe and to have hands-on learning experiences.

Recommendations

Based on the findings of this study, the following recommendations seem appropriate:

1. Selected Community Colleges should add aquaculture to their course listings. The task listing and task detailing should be used to develop the courses. The study of aquaculture should expose students to aquatic species, cultivation practices and management, construction and operation of an aquafarm, and identity and management of problems encountered in the industry. Currently, there do not appear to be a need for a program, perhaps a certificate of completion in aquacultural studies would be appropriate.

2. Practical "hands-on" experiences in aquafarm operations should be gained through cooperative agreement with aquafarm operators and, if possible, on a "mini aquafarm site" or laboratory within near proximity to the college campus.

3. For the transfer student there should be a knowledgeable advisor experienced in the field of aquaculture to counsel and advise in the selection of courses. There are many recommended related courses that can be taken from the existing lists of courses.
4. There appears to be a need, but this should be verified, for aquaculture seminars/workshops to be offered at nights or on weekends. This would allow interested persons in the community and in-service workers the opportunity for aquacultural training.
5. A manpower need survey be conducted in five years to determine if a full technician level aquaculture program leading to a certificate of achievement or associate in science degree are justified.

REFERENCES

Bardach, J., et al. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organism. Wiley-Interscience, 1972.

Conversation with Dupont; 1980.

Conversation with Mr. K. Gopalakrishnan, Oceanography Instructor, Honolulu Community College, 1980.

Conversation with Provost Clyde Yoshioka, Honolulu Community College, 1980.

Conversation with Mr. Jeffrey W. Hunt, Instructor, Windward Community College, 1980.

Corbin, J. Aquaculture in Hawaii, 1976: Progress, Resources and Organization. State of Hawaii: Department of Planning and Economic Development, 1976.

Department of Planning and Economic Development. Aquaculture Development for Hawaii. Honolulu, Hawaii 1978.

Huet, M. Textbook of Fish Culture: Breeding and Cultivation of Fish. England: Page Brothers Ltd., 1972.

Lee, S. Hawaiian Prawn Industry: A Profile. Honolulu: Aquaculture Development Program, Department of Planning and Economic Development, 1979.

Mager, Robert F. Goal Analysis. Belmont, California: Fearon Publishers/ Lear Siegler, Inc., 1972.

Mager, Robert F. Developing Vocational Education. Belmont, California: Fearon Publishers/Lear Siegler, Inc., 1967.

Shklov, J., et al. Getting Started With Prawns. Honolulu, Hawaii: U.H. Sea Grant Program, Marine Advisory Program, 1978.

State Advisory Council on Vocational Education. Annual Report, 1978. Honolulu, Hawaii 1979.

U.S. Department of Agriculture. Catfish Farming. Farmer's Bulletin No. 2260. Washington, D. C.: U.S. Government Printing Office, 1975.

U.S. Department of Labor, Manpower Administration. Handbook for Analyzing Jobs. Washington, D. C.: U.S. Government Printing Office, 1972.

Yim, T. C. Senate Aquaculture Report: Problem, Solution, and Further Actions Needed for the Development of an Aquaculture Industry for Hawaii. State of Hawaii: Printing Office, 1977.

APPENDIX A

UNIVERSITY OF HAWAII

Office of the Chancellor for Community Colleges

October 11, 1979

Dear

The University of Hawaii Community Colleges desire your cooperation in conducting a task analysis of the jobs that are directly involved in aquacultural farms. Task analysis is the process of examining and recording the actual activities performed by a worker, the frequency of the activities, and the degree of difficulty of the activities.

The data will be used by the Community Colleges to assess the feasibility of starting aquaculture vocational education programs to train people to work on aquacultural farms.

Your cooperation in permitting a researcher to visit your farm for a few days and to observe the workers will permit us with the means to properly conduct the analysis. Ms. Elaine Dung, who is the field observer/task analyst, will be contacting you as soon as you permit us to visit your farm.

Please complete the attached questionnaire and return it in the self-addressed stamped envelope by October 26, 1979. If you have any questions, please contact Dr. Lawrence Wakui at 948-6976. Thank you.

Sincerely,

E. H. Mookini

Edwin H. Mookini
Chancellor for Community Colleges

Attachments

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APPENDIX B
AQUACULTURAL OCCUPATION TASK ANALYSIS QUESTIONNAIRE

Name: _____ Firm: _____

Please answer the questionnaire to the best of your ability.

☐ YES, you may visit to observe workers.

Person who should be contacted: _____

Phone Number: _____

☐ NO, you may not visit.

Reason: _____

Number of employees on the farm:

No. of manager(s) _____

No. of technician(s) _____

No. of laborers _____

No. of part-time employees _____

TOTAL _____

The most suitable time and dates to visit my farm (or institution) for observing various tasks are:

General Tour:

date: _____

time: _____

Feeding Schedule:

dates: _____

times: _____

Harvesting Schedule:

dates: _____

times: _____

Maintenance and Repairs:

dates: _____

times: _____

type of maintenance/repair: _____

_____

Construction Schedule:

dates: _____

times: _____

type of construction: _____

_____

Other: _____

Species cultured: _____

The water source for the pond systems is:

☐ underground

☐ run-off

☐ agricultural

☐ ocean

☐ other: _____

☐ fresh ☐ brackish ☐ ocean

The disposable pond water is then:

☐ discharged into _____

☐ recycled by _____

☐ other _____

Other comments:

Please return this questionnaire in the self-addressed envelope by October 26, 1979. Thank you.

Elaine Dung
Field Observer/Task Analyst
Office of the Chancellor for Community Colleges
2444 Dole St., BA 13
Honolulu, Hawaii 96822

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